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"HISTORY OF THE MK 27 WEAPON (U)"

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Weapon Systems

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Timetable of Events

Mk 27 Weapon

Late 1953 Plans made to develop a small, two-stage weapon.

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8/5/54

(b)(1), (b)(3)

6/6/55

7/6/55 Division of Military Application assigns Mk 27 development to Radiation Laboratory and Sandia-Livermore.

8/9/55

(b)(1), (b)(3)

6/27/56 Special Weapons Development Board discusses proposed ordnance characteristics of the TX-27 weapon.

(b)(1), (b)(3)

8/21/57 Mk 27 Bomb design released.

10/21/59 Final evaluation report of Mk 27 Mod 0 Bomb presented to Special Weapons Development Board and accepted.

Mod 1

6/22/59 Division of Military Application proposes that manual arming capability of the fuzing system be deleted.

9/28/59 Sandia provides ready-safe switch for above purpose, creating the Mk 27 Mod 1.

Mod 2

10/21/60 Sandia proposes that a squib-actuated switch be replaced with a solenoid actuated design, to prevent activation of the squib switch by radio-frequency energy. This resulted in the Mk 27 Mod 2 design.

REGULUS Warhead Application

5/21/55

(b)(3)

8/12/55 Sandia submits proposed scope of work for adaption kit for XW-27/ REGULUS I.

1/25/56 Special Weapons Development Board discusses proposed ordnance characteristics of the XW-27 Warhead and its missile applications.

3/27/57 W27/REGULUS I design released.

4/23/58 Final engineering evaluation of the Mk 27 Mod 0 REGULUS I Warhead Application presented to and accepted by the Special Weapons Development Board.

RASCAL Warhead Application

Mid-1955 Missile considered for XW-27 application.

1-57 Application design release issued.

4/23/58 Final engineering evaluation of the Mk 27 Mod 0/GAM-63A (RASCAL) Warhead application presented to and accepted by the Special Weapons Development Board.

B-58/HUSTLER Application

Summer 1953 Feasibility study of XW-27/B-58 proposed.

1/18/56 Project authorized for design.

6/57 Project canceled.

TRITON Warhead Application

8/54	Feasibility study for XW-27/TRITON authorized.
12/9/55	Project canceled.

MATADOR Warhead Application

12/16/54	(b)(3)
11/56	XW-27/MATADOR project canceled in favor of XW-28/MATADOR.

SHAPE 96 Warhead Application

1/12/55	Air Force Special Weapons Center states that project appears feasible.
5/24/55	Santa Fe Operations Office authorizes full development.
3/56	Project canceled.

HISTORY OF THE MK 27 WEAPON

In late 1953, as the design of the TX-15 began to crystallize, it became evident that major weight and size reductions of thermonuclear devices were possible.

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The weapon would be carried by the Army REDSTONE missile; the Navy REGULUS I, REGULUS II, and TRITON; and the Air Force B-58 Pod, MATADOR, SNARK, RASCAL and NAVAHO. The bomb weight was not to exceed 3000 pounds. It was to be capable of either internal or external carriage on the Navy AJ, A2U, A3D, A4D, F3H, F7U, P6M and F2H; and the Air Force B-47, B-52, B-57, B-66, F-84, F-100, F-101 and F-105.

The bomb would be able to withstand, without damage or functional impairment, forces and accelerations caused by catapulted takeoffs, arrested landings, ejection, and normal flight maneuvers. A surface-burst contact fuze was desired, selectable in flight as a primary burst option, but a radar fuze producing a near-surface burst would be acceptable if a true contact fuze could not be achieved. An air-burst fuze would be capable of being set to the desired burst height after takeoff, and a contact or near-surface fuze would provide cleanup. The weapon would be capable of remaining in a ready-for-use condition for as long a period of time as possible, but not less than 30 days.[3]

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(b)(3)

It was hoped that the devices would be produced in late 1956, by which date suitable delivery aircraft would be available. It was felt, however, that if a maximum bomb weight of 3000 pounds was maintained, the warhead weight might be less than the specified 2800 pounds, and that it would have a correspondingly lower yield. However, if the warhead weight was maintained at 2800 pounds, the bomb weight would probably exceed 3000 pounds. The Los Alamos Scientific Laboratory wanted as large a warhead diameter as possible, while Sandia hoped that the diameter could be kept to a minimum to ease external carriage problems.

This discussion was continued in the September 17, 1954 meeting of the TX-Theta Committee. Weapon diameters from 20 to 35 inches were examined, together with five general shapes. As indicative of the penalties created by external carriage, it was noted that a store with a diameter of 30 inches and a weight of 3000 pounds could be carried by the F-100C. If this weight were increased by 500 pounds, the ceiling of the aircraft would be reduced 500 feet and its range shortened 20 nautical miles. The drag of such an external store was almost 20 percent that of the airplane, and this drag increased about 30 percent if the bomb diameter were increased 5 inches.

(b)(3)

Delivery studies had been made by Sandia.

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The use of a safe-separation timer to provide adequate aircraft escape time after release was recommended.[5]

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(b)(1), (b)(3)

The reasons behind this proposal were that missiles could accommodate warheads up to 44 inches in diameter, but this size was incompatible with external carriage on most aircraft. External aircraft carriage considerations dictated that a bomb with a diameter close to 30 inches be used, and having a structure that could withstand lug and sway brace loads. Additionally, in view of the present circular error inherent in missiles, it was felt advisable to provide a missile warhead with the highest possible yield.[7]

This proposal was forwarded to the Santa Fe Operations Office November 17. 1954.

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It would be compatible with the missiles intended as carriers for the XW-5 Warhead, although some minor warhead compartment modifications might have to be made.

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This was followed by another letter, March 24, 1955, noting that production interest would depend on the yield attained.[9]

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A meeting was held June 6, 1955, with representatives of the University of California Radiation Laboratory and Los Alamos present, and resulted in a suggestion that Livermore produce the weaponized version of the XW-27.

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(b)(1), (b)(3)

The use of an unboosted primary was discussed in a teletype from the Radiation Laboratory to the Division of Military Application July 1, 1955.

(b)(3)

The shape selected was a reduced-scale Mk 15, with a diameter of 30-1/4 inches and a length of 115 inches, and was chosen due to the proven ballistic and fuzing characteristics of the Mk 15.

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Santa Fe Operations Office notified the Division of Military Application July 13, 1955, that the XW-27 case design posed extensive new engineering problems, and that any predicted time scales would have to be viewed with somewhat less than normal confidence. However, the Radiation Laboratory and Sandia were hopeful of freezing the design by January 1, 1956.[15]

The bomb weight would be kept to a minimum. It would be internally carried in the Air Force's B-47, B-52 and B-66; and in the Navy's AJ, A3D, A3J and P6M. A surface-burst contact fuze was required, which could be selected in flight as the primary burst option, or rendered inoperable prior to flight. The height of burst in the air-burst option would be as near one fireball radius above the target as possible.[18]

The Division of Military Application wrote to Santa Fe Operations Office September 13, 1955, requesting that the Radiation Laboratory and Sandia proceed jointly in the XW-27 program. An operational availability date of October 1957 was desired, provided that this could be met without interference to other programs.[19] Subsequently, September 23, 1955, Santa Fe Operations Office authorized full-scale development for the TX-27 internally carried bomb and the XW-27 warhead programs.[20]

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(b)(1), (b)(3)

It was felt that the bomb design could be released in April 1957, with early production about one year later. The bomb requirements would not adversely affect the nuclear performance of the warhead. The bomb might have a maximum diameter of 30-1/4 inches, an overall length of about 125 inches, and a weight of 3300 pounds. Since the case would be relatively weak, strong handling points would have to be provided.[22]

Sandia notified Field Command December 22, 1955, that the Military Characteristics for the TX-27 designated the same carrying aircraft as for the TX-15, with the exception of the A3J. This similarity in diameter and length of the two weapons had prompted studies aimed at use of the TX-15 suspension system with as little change as possible. It would be necessary to reinforce a large portion of the weapon, and the effect of this reinforcement on weapon yield would have to be determined.

(b)(1), (b)(3)

The Services were requested to submit requirements for aircraft bomb suspension, both for a drop-test program and to allow evaluation of the case design from the standpoints of strong areas and structural requirements.[23]

By early 1956, it had been decided that thermal batteries would be used. It was felt that a barometric fuze would be suitable for the air-burst option. A safe-separation device would be necessary, since some of the aircraft designated as carriers would release bombs at low altitudes.

A trajectory arming device would be included to minimize the possibility of detonation during ground handling or takeoff accidents. The use of air scoop, differential pressure, ram pressure, spin, or roll integration had been considered, and a squib-initiated differential-pressure device being developed for the TX-28 appeared promising. A mechanical clock timer, also being designed for the TX-28, could be used if a timer were required, but its contacts closed only for a 3-second period and continuous closure would have to be provided by a hold-down device. A manually adjustable baroswitch, used in the TX-15, should be suitable for arming and firing, and would provide a close-arming capability.[24]

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The impact fuze was tested to determine whether rain or hail would cause premature or accidental operation.

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The number and location of the contact-fuze elements were slightly changed, to provide better impact response. Sled tests were felt to be unnecessary, and were canceled.[32]

Report SC3776(TR), Proposed Ordnance Characteristics of the TX-27 Weapon, was discussed in the June 27, 1956 meeting of the Special Weapons Development Board. The weapon was described as an internally carried, free-fall bomb, 30-1/4 inches in diameter, 128 inches long, and about 3200 pounds in weight. The weapon consisted of a nose case, warhead, fuze compartment, rear case section with fins, and split band joining the fuze and warhead sections. All compartments were sealed against the weapon environment, with the exception of the split-band and rear-case areas which ~~contacted~~ contained no critical components. The weapon could be carried in the Air Force B-47, B-52 and B-66; and the Navy AJ, A3D, A3J and P6M. The A3J application involved replacement of the weapon tail by two fuel tanks, each 30 inches in diameter and 100 inches long, and the overall length of this configuration was about 300 inches.[33]

Meanwhile, difficulty had been encountered in trying to reduce the weight of the weapon. The Military Liaison Committee, on July 5, 1956, noted that a weight increase of 300 pounds over the military characteristics could be tolerated, but would be accepted only on an interim basis.

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Sandia and the Radiation Laboratory jointly reported to the Division of Military Application August 10, 1956, that it would not be possible to reduce the weight of the warhead to 2800 pounds and maintain the yield, and an increase of 100 pounds was mandatory.

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Compatibility problems were also given attention. Multiple carriage of the TX-27 Bomb in the P6M and A3D aircraft was proposed. The bomb fin span precluded carriage of more than one weapon in the A3D, and Sandia investigated the possibility of reducing this fin span. Suitable shapes were tested in the wind tunnel, and it was felt that the fins could be satisfactorily contained within a box whose sides were tangent to the major diameter of the bomb, although the bomb length would have to be increased to 142 inches over its current 125 inches.[36]

Studies had been made of suitable shapes for external carriage, and one with a diameter of 30-1/4 inches, length of 250 inches, and weight of about 3300 pounds was suggested. It was found that this shape was suitable for use with the F-101, F-107, F-108 and RB-47, but was not compatible with the A4D.

Performance degradation, even with semisubmerged carriage, would reduce the top speed of the F-101 approximately 100 knots and that of the F-107 about 20 knots, with the range of both aircraft being shortened some 100 nautical miles. Carriage on the RB-47, using fuselage elbow pylons, would reduce airplane performance about 5 knots and would affect the range slightly.[37]

By early October 1956, wind-tunnel tests of the 125-inch shape had indicated that this configuration was fairly stable. However, the barometric pressure ports would have to be located in the rear case between the fins. This location could not be used on the A3J, as the weapon tail would be replaced by the fuel tanks.

Since a barometric port common to both configurations was desirable, studies were made of a modified Mk 16 shape 142 inches long, having a small box fin, and it was found that a common baro port could be developed. Test data indicated that a spoiler band at Station 82, which was required for the 125-inch shape, was also suitable for the longer case. A change to the longer length would thus provide compatibility with the B-57 and allow multiple-carriage for the A3D and B-66.[38] Air Force requirements for external carriage were canceled October 12, 1956, when the F-101 and RB-47 were eliminated, but the bomb length was left at 142 inches.[39]

Provision for both sling and lug suspension was requested in mid-1956, to provide added operational flexibility.[40] Sling suspension had already been designed, and Sandia subsequently provided removable lugs. The Air Force deleted all TX-27 carriers, except the B-47 and B-52, in December 1956, and these used sling suspension only.[41] However, the Navy required lug suspension for the A3D, and the capability was left for this application.[42]

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The Mk 27 Mod 0 Bomb was design released in May 1957 and achieved production in October 1958. Report SC4091(TR), Description and Status Report at Design Release of the TX-27 Bomb, was presented to the August 21, 1957 meeting of the

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The signal that triggered the high-voltage battery squibs had to be received about 2-1/2 seconds before weapon detonation, to permit charging the X-unit.[48]

The operating sequence of the TX-27 Bomb was as follows: The selector switch in the aircraft was moved to either the air-burst or the ground-burst position, thus placing the low-voltage arm/safe switch in operating position. As the bomb was released, pullout wires activated pulse generators, and this brief pulse of power was applied to a transformer. This pulse transformer had two primary windings, either of which could supply enough energy to fire all the battery squibs. One transformer secondary was connected to a squib-operated monitor switch that fired simultaneously with the battery squibs. This monitor switch provided a simple continuity test for the battery condition; if the switch was open, the batteries had not been activated.

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If air-burst option had been selected, weapon detonation occurred when the firing baroswitches closed. This firing was accomplished by pulsing the trigger transformer, thus operating the thyratrons, causing the gap to break down, and connecting the output of the X-unit capacitors to the detonators of the primary. The output of the primary then compressed the secondary and initiated the fusion reaction.

If ground burst option had been selected, the impact crystal network, operating through the secondary of the saturable core transformer, supplied a voltage pulse to the thyratrons which, in turn, fired the X-unit. If a ground burst signal had been given to the transformer, with the core having been driven to saturation in a given direction, and then the air-burst signal supplied, the weapon would not fire, as there would not be enough change in flux to pulse the transformer. As the bomb continued to fall in its trajectory, however, there would be a detonation when it struck the ground, since the contact burst signal would fire the circuit. In the event the air-burst signal did not operate properly, the ground burst signal would provide backup. The contact fuze network could be disconnected for contact preclusion.[49]

The Division of Military Application sent a teletype to Albuquerque Operations Office, June 22, 1959, noting that manual operation of the arm-safe switch was required and suggesting that action be taken to provide a safer design.[50] Sandia proposed a change, September 28, 1958, which would replace the arm-safe switch with a ready-safe design, operable only by remote control. This would decrease the possibility of sabotage or willful destruction of the Mk 27.[51] The proposal was accepted and resulted in creation of the Mk 27 Mod 1 Bomb.

Sandia subsequently proposed another change, October 21, 1960, which would replace a squib actuated switch in the Mk 27 Bomb and Warhead with a switch that was solenoid operated.[52] It had been found that recent developments in communication transmitters had resulted in higher radio frequency energies being used. This amount of energy, it was felt, might activate the squib switch.[53]

The change was incorporated and resulted in development of the Mk 27 Mod 2 Bomb and the Mk 27 Mod 1 Warhead. Report SC4925(WD), Final Evaluation of the

The adaption kit would permit storage for a period of at least 5 years, and be capable of reliable operation after being installed in the missile for 75 days. The weight of the adaption kit would be a minimum, with the gross weight of kit and warhead not exceeding 3000 pounds.[58]

On August 12, 1955, Sandia submitted a proposed scope of work for the development of the adaption kit for the XW-27/REGULUS I. The first kit would be available for flight testing in March 1956, and complete design release would be in January 1957.[59] This scope of work was approved August 26, 1955.[60]

Early design studies showed that all the possible configurations of the XW-27 which was acceptable from the physics standpoint would result in interference with the REGULUS I air scoop. Agreements were reached to modify the air scoop.[61]

Sandia informed the Bureau of Ordnance September 2, 1955, that the development of a continuously adjustable safe-separation timer would require 3 months of development effort. If, however, the timer requirements could be revised to specify only a capability for either 2 or 10 minutes, the complexity of the device would be reduced, and development time and cost would be saved.[62] This suggestion was adopted.[63]

A radar fuze had been proposed for air burst, but Sandia noted that the required 600-foot accuracy in burst height could be attained with a barometric fuze. This fuze would eliminate any electronic countermeasures problem, simplify assembly and preflight procedures, and reduce weapon support.[62]

The operational characteristics of the XW-27 Warhead required that nuclear and electrical arming be performed shortly before weapon burst. This obviated the need for command arming, since arming would not occur until the weapon was definitely committed. This requirement would also eliminate the need for automatic arming at the end of safe-separation time.[62]

Details of the adaption kit now became firm. Thermal batteries would provide power to charge the X-unit. The primary would be gas-boosted, and the adaption kit would supply signals to arm and initiate warhead operation. The fuze would be baroswitch-operated, with contact crystals furnishing backup. This fuze would also be capable of accepting radio-command arming and firing signals.

The safe-separation timer would be started by closure of an acceleration switch at missile launch. Additional safety would be provided by a device to connect the thermal battery to the X-unit only after the arming signal had been received. The warhead dimensions were 30-1/4 inches in diameter, 70-1/2 inches in length, and 2800 pounds in weight.

By the end of 1955, a close-arming concept had been adopted, to minimize premature detonation by activation of the impact crystals through enemy antiaircraft fire. This was accomplished by setting the arming baroswitch to operate only a short distance above the firing baroswitch.

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Sandia discussed the adaption kit for the XW-27/REGULUS December 23, 1955. Two missile flight profiles were described. The first was a high-altitude flight at 35,000 feet to the target area, with the missile descending to the target in a vertical dive. Arming and firing of the warhead would take place during this dive, and would be accomplished by the adaption-kit fuze. The missile was also to be capable of flight at low altitudes, and would be flown horizontally over the target at the desired burst height. Arming and firing would be accomplished by command signals sent over the missile guidance system.

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The adaption kit would include the fuzing system and the supports for the warhead and fuzing system in the missile. The fuzing system would have several new features. These included an acceleration-sensitive switch in place of a lanyard-operated switch as in previous designs, thereby eliminating the requirement for pullout wires. A safe-separation timer would provide two preset time intervals of 2 and 10 minutes, either of which could be selected just prior to launch. This option selection, previously accomplished by arming plugs, would be by selector switch located on the launch panel. The system would be designed for a long-term ready-weapon capability, possibly 18 months under semicontrolled environmental conditions.[65]

By early 1956 the fuzing system was taking shape. The acceleration-sensitive switch would prevent inadvertent charging of the X-unit during storage and while the weapon was being readied for use.[66] This switch contained two sets of air pistons, operated by the launch acceleration, which would close a set of contacts when the warhead was subjected to a 4 g-second impulse. The contacts were spring-loaded, so that a force less than 1-1/2 g's would not close the contacts.

The safe-separation timer contained two sets of motor-driven gear and cam assemblies which closed electrical switches at the end of the timing intervals. One pair of switches closed at the end of 2 minutes, and the other at the end of 10 minutes. Timer action was started by missile-launch action.

The high-voltage thermal batteries for charging the X-unit were isolated by a squib-operated arm switch. During the safe-separation interval, power was kept from the warhead arming and firing circuits by the acceleration switch and the safe-separation timer.

(b)(3)

which controlled the pressure altitude at which the switches would close. An odometer, built into the knob, allowed the firing altitude to be read directly. Another set of four switches, wired into an arming network, was factory-adjusted to close at a specified altitude above the firing network. This furnished close arming, regardless of fuze setting.[67]

For the ground-burst option, the arming baroswitch closed at the arming altitude, with the firing baroswitch being disconnected from the circuit. The X-unit trigger circuit received a firing signal from the impact crystal network in the missile nose.

Sandia notified the Bureau of Aeronautics October 31, 1956, that the XW-27/REGULUS I flight tests, which were launched from Pt. Mugu, California, and impacted in the water at Salton Sea Test Base, had been highly successful. The Sandia-designed items were ready for certification, and the flight-test program would be completed with the seventh flight.[69,70]

The design release of the W-27/REGULUS I program was issued March 27, 1957.[71] This included the adaption kit and all test and handling equipment, with the exception of one item that was released in late April 1957.[72]

The Military Liaison Committee notified the Atomic Energy Commission July 3, 1957, that the Navy's operational-availability-date objective for the XW-27/REGULUS I adaption kit was October 1957, which matched the availability date of the warhead. However, production of the adaption kit had lagged the warhead time scales, and since kit hardware would not be available until February 1958, the warhead would be delayed until this date.[73] The warhead date was then slipped several months.[74]

Report SC4165(TR), Final Engineering Evaluation of the Mk 27 Mod 0 REGULUS I Warhead Application, was presented by Sandia to the April 23, 1958 meeting of the Special Weapons Development Board. The Board accepted the report for forwarding to the Division of Military Application.[75,76]

In the meantime, some work had been done on the REGULUS II application. Santa Fe Operations Office placed this program in full development January 18, 1956, as the first tactical REGULUS II missile was to be available by September 1957.[77] A proposed scope of work for the flight-test program was originated by Sandia, including 11 flights from Edwards Air Force Base, California.[78] However, the program was subsequently canceled.

RASCAL Warhead Application

The RASCAL was an air-to-surface, rocket-powered, supersonic missile with a range of about 90 nautical miles. The missile was 4 feet in diameter and 32 feet long, with one set of four fins near the nose and another set at the tail. The missile was designed and built by the Bell Aircraft Company for the Air Force. Its name was formed from the term RAdar SCAnning Link.

The missile was considered for XW-27 application in mid-1955. Some concern was created by the limitation imposed by the usable length of the warhead compartment in the missile, which was 77 inches. The location of the missile's air scoop was changed, along with modifications to the warhead support structure, adaption-kit components, and the main missile power supply, to avoid nuclear mass discontinuity problems.[14]

Enough progress had been made along these lines so that Sandia suggested to the Air Force Special Weapons Center November 30, 1955, that the XW-5-X1 Warhead could be canceled for application to the RASCAL, leaving the XW-27 as the sole warhead requirement.[79] This proposal was accepted, and early flight tests were made in the fall of 1956. An application design release was issued in January 1957, with the complete engineering release being made January 22, 1958.[80]

Report SC4164(TR), Final Engineering Evaluation of the Mk 27 Mod 0 GAM-63A (RASCAL) Warhead Application, was presented to the April 23, 1958 meeting of the Special Weapons Development Board.

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The Board accepted the report for forwarding to the Division of Military Application.[75,81]

a streamlined fighter plane with a maximum diameter of slightly over 4 feet, length of 39 feet, and swept-back wings. It was launched by a single, solid-propellant rocket, which accelerated the missile until the turbojet engine could attain sufficient thrust to sustain flight.

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The XW-27/MATADOR project was canceled in November 1956.[88]

SHAPE 96 Application

(b)(3)

~~Santa Fe Operations Office~~ authorized full development work on the XW-27/F-101 project May 24, 1955.[89]

Design study indicated, however, that the Shape would require major modification to support the warhead and, since difficulties were being encountered with Shape 96, the project was canceled in March 1956.[90]

Glossary of Mk 27 Terms

Adaption Kit -- Those items peculiar to the warhead installation less the warhead; namely, the arming and fuzing system, power supply, and all hardware, adapters and the like, required by a particular installation.

Air Force Special Weapons Center -- That element of the Air Force Systems Command having to do with compatibility testing of nuclear devices with aircraft. Located at Kirtland Air Force Base, Albuquerque, New Mexico.

Albuquerque Operations Office -- The local office of the Atomic Energy Commission (AEC) concerned with the operations of Sandia Corporation.

Arming -- The act of arming a weapon, that is, preparing it for firing.

Assistant Secretary of Defense -- Created by Department of Defense Directive, June 30, 1953, as part of DOD reorganization. Handles research and development activities of the DOD.

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Department of Defense -- The Armed Forces, i.e., the Army, Navy and Air Force.

Design Review and Acceptance Group -- A Military committee established to review the design of a specific weapon.

Detonators -- Devices containing bridge wires which, when subjected to an electrical current, burn rapidly and act as a match to apply a flame to various points on the outer surface of the high-explosive sphere.

Deuterium -- The hydrogen isotope of mass number 2.

Division of Military Application -- An AEC office that functions as liaison between the Military and weapons designers and producers.

Dump -- The point in its trajectory at which a guided missile "dumps" or turns toward the target.

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Field Command -- The local office of the Armed Forces Special Weapons Project located on Sandia Base, Albuquerque, New Mexico.

Firing System -- The electrical system of the weapon that produces and applies a high-voltage current to the detonators.

Fissile Material -- Material capable of being fissioned.

Fuzing System -- The system that signals the start of high-voltage charging of the firing system.

g -- Force equal to one unit gravity.

Gas Boosting -- The technique of increasing the yield of a nuclear device by introducing deuterium-tritium gas into the implosion process to increase the fission activity.

Ground Burst -- Detonation at or very close to the surface of the bomb or target.

High Explosive Sphere -- The ball of high explosive that surrounds the nuclear ~~primary and~~ produces the implosion effect when detonated.

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Jato -- Named for Jet-Assisted Take-Off. A jet device initially designed to assist heavily loaded aircraft to take off from short runways. Used as a boosting device in missile launching.

Joint Chiefs of Staff -- ~~An~~ Army, Navy, Air Force ~~group~~ to determine policy and to develop joint strategic objectives of the Armed Forces.

Kilogram -- A metric weight approximating 2.2 pounds.

Kiloton -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is equivalent to the detonation effect of 1000 tons of high explosive.

Kilovolt -- 1000 volts.

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Megaton -- A measure of yield of a large weapon. One megaton is the equivalent of 1,000,000 tons of high explosive.

Military Characteristics -- The attributes of a weapon that are desired by the Military.

Military Liaison Committee -- A Department of Defense committee established to advise and consult with the AEC on all matters relating to military applications of atomic energy.

Nautical Mile -- A naval measurement of length. One nautical mile is equivalent to 6076.1033 feet, or the length of 1 minute of arc (1/21,600) of a great circle of the earth.

Neutron -- An uncharged particle of slightly greater mass than the proton.

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Teapot -- A less-than-full-scale test series held at the Nevada Test Site. Series of 14 tests, starting February 18 and ending May 15, 1955.

Thermal Battery -- A battery whose electrolyte is in a solid state while inactive. To activate, heat is applied to this electrolyte, melting it and putting the battery into active output condition.

Thermonuclear -- Two-stage reaction, with a fission device exploding and starting a fusion reaction in light elements.

Thyratron -- A grid-controlled electron tube.

Transonic -- A speed approximating that of Mach 1.0, the speed of sound; or 738 miles per hour at sea level.

Tritium -- The hydrogen isotope of mass number 3.

Two-Stage -- Combination of fission and fusion action in a weapon.

TX-Theta Committee -- A committee established to guide the development of thermonuclear weapons.

University of California Radiation Laboratory -- A nuclear design organization located at Livermore, California.

Uranium-235 -- A radioactive element, an isotope of uranium-238.

Uranium-238 -- A radioactive element, atomic number 92. Natural uranium contains about 99.3-percent uranium-238; the rest is uranium-235.

Warhead -- As used in this history, a weapon carried to the target by missile.

X-Unit -- ~~A high-voltage transformer.~~ A device used to provide high voltage to the weapon detonators.

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